EUSO-SPB2: second generation Extreme Universe Space Observatory on a Super-Pressure Balloon, University of Alabama in Huntsville Co-I

Active Technology Project (2018 - 2022)

Project Introduction

TITLE: EUSO-SPB2: second generation Extreme Universe Space Observatory (EUSO) on board a Super-Pressure Balloon (SPB), The University of Alabama in Huntsville, Co-I PROPOSAL Summary: This is the Co-Investigator Proposal for EUSO-SPB2, second generation Extreme Universe Space Observatory on a Super-Pressure Balloon, being led by PI Angela V. Olinto at the University of Chicago. We propose to design, build, deploy, and publish the scientific results of a second generation of the Extreme Universe Space Observatory (EUSO), to be flown aboard a Super-Pressure Balloon (SBP). EUSO-SPB2 will monitor the night sky of the Southern hemisphere to study cosmic rays of very high to ultrahigh energies and pioneer the search for cosmogenic tau neutrinos from space. EUSO-SPB2 will be the first instrument to observe Cherenkov light from extensive air-showers high in the atmosphere. EUSO-SPB2 will observe a large sample of cosmic rays from 0.1 to 1 EeV with the Cherenkov technique and will discriminate among the Cherenkov profiles of primary protons, heavy nuclei, and photons. It will also characterize the background for upward going showers initiated by the decay of tau leptons, which are expected to be produced by Earth-skimming tau neutrinos. A coincidence veto will be developed for EUSO-SPB2 so it can characterize the background for Cherenkov signals from the neutrino produced tau leptons. EUSO-SPB2 will also use fluorescence observations to measure, for the first time, the evolution of nearly horizontal high altitude extensive air showers, which develop at the nearly constant low-density atmosphere. Such measurements will provide a unique channel to probe hadronic interaction models at ultrahigh energies, and may elucidate the reason why ultrahigh-energy cosmic ray (UHECR) showers observed by ground-based detectors contain more muons than expected from hadronic interaction models. EUSO-SPB2 is a pathfinder for the more ambitious space-based measurements by the Probe Of Extreme Multi-Messenger Astrophysics (POEMMA), currently proposed for a NASA design study. POEMMA will combine the well-developed Orbiting Wide-field Light-collectors (OWL) concept with the recently proposed CHerenkov from Astrophysical Neutrinos Telescope (CHANT) concept to form a multi-messenger probe of the most extreme environments in the universe. EUSO-SPB2 will inform the best strategy for future space missions such as POEMMA. EUSO-SPB2 will build upon the experience of flying EUSO-SPB1 in the Spring of 2017. A number of upgrades will render EUSO-SPB2 more powerful, including a Schmidt design telescope and a faster ultraviolet (UV) camera to increase exposure. The new instrument will detect Cherenkov and fluorescence signal from highly inclined UHECR events. Horizontal observations will lead to much larger acceptance with a distance-dependent energy threshold. Depending on EUSO-SPB1 results, EUSO-SPB2 may also point closer to nadir in fluorescence. The combination of nadir (EUSO-SPB) and tilted (EUSO-SPB2) observations will explore the power of space observatories to observe UHECR of extreme energies. A long enough flight of EUSO-SPB2 observations will match and complement ground observations. EUSO-SPB2 addresses the fourth science goal of the 2011 NASA Strategic

EUSO-SPB2: second generation Extreme Universe Space Observatory on a Super-Pressure Balloon, University of Alabama in Huntsville Co-I

Table of Contents

EUSO-SPB2: second generation Extreme Universe Space Observatory on a Super-Pressure Balloon, University of Alabama in Huntsville Co-I

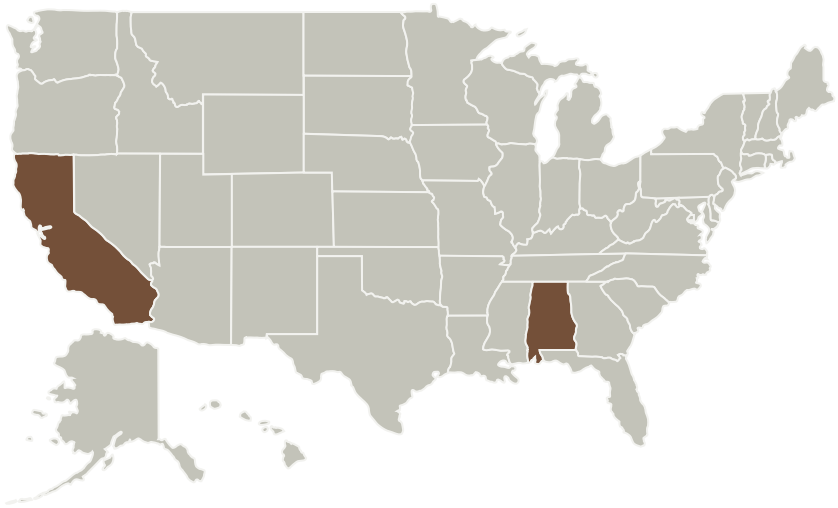
Active Technology Project (2018 - 2022)

Plan, to "Discover how the universe works, explore how it began and evolved" and one of the "Physics of the Cosmos" questions in NASA's 2010 Science Plan: "How do matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos?" EUSO-SPB2 directly addresses the sixth question in the "Connecting Quarks with the Cosmos" report in its list of "Eleven Science Questions for the New Century," which is "How do Cosmic Accelerators Work and What are They Accelerating?"

Anticipated Benefits

The Astrophysics Research and Analysis program (APRA) supports suborbital and suborbital-class investigations, development of detectors and supporting technology, laboratory astrophysics, and limited ground based observing. Basic research proposals in these areas are solicited for investigations that are relevant to NASA's programs in astronomy and astrophysics, including the entire range of photons, gravitational waves, and particle astrophysics. The emphasis of this solicitation is on technologies and investigations that advance NASA astrophysics missions and goals.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Alabama in Huntsville(UAH)	Lead Organization	Academia	Huntsville, Alabama

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

University of Alabama in Huntsville (UAH)

Responsible Program:

Astrophysics Research and Analysis

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Patrick J Reardon

Co-Investigators:

James Adams
Gloria W Greene
Evgeny N Kuznetsov

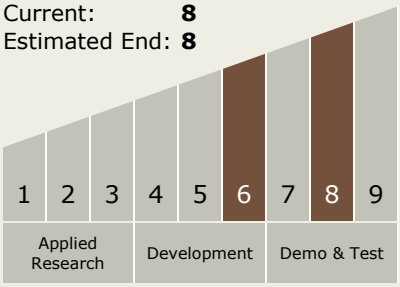
EUSO-SPB2: second generation Extreme Universe Space Observatory on a Super-Pressure Balloon, University of Alabama in Huntsville Co-I

Active Technology Project (2018 - 2022)

Primary U.S. Work Locations	
Alabama	California

Technology Maturity (TRL)

Start: **6**
Current: **8**
Estimated End: **8**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System